22. Like all futures contracts, interest rate swap futures contracts are cleared through a derivatives clearing organization, which acts as an intermediary between counterparties for the settlement or netting of transactions. In the current matter, the Three Month Contract was cleared through IDCH, a CFTC-registered clearing organization.[26] As the clearinghouse, IDCH was the central counterparty for all transactions involving the Three Month Contract, thus undertaking all counterparty default risk. That is, IDCH is the buyer to every seller and the seller to every buyer. If a party to a transaction defaults, then the loss would be borne by IDCH. To reduce its exposure to counterparty default risk, IDCH required a minimum deposit amount that an investor needed to make to take a position in the futures contract as required by the exchange. This minimum deposit amount is the *initial margin*.

23. As noted above, interest rate changes influence the daily settlement price of interest rate swap futures contracts. At the close of each trading day, positions in the futures contract are marked to market based on a daily settlement price determined by the exchange or clearinghouse. As such, any gain or loss in a given position is reflected daily in the settlement price of the position. Interest rate movements that reduce the settlement price (or the daily marked-to-market value) of a counterparty's open position require that counterparty to make an additional margin deposit (called the *variation margin*).[27] Conversely, interest rate movements that improve the daily marked-to-market value of a counterparty's open position result in that counterparty receiving variation margin. In other words, parties that hold open positions to the futures contract are subjected to cash

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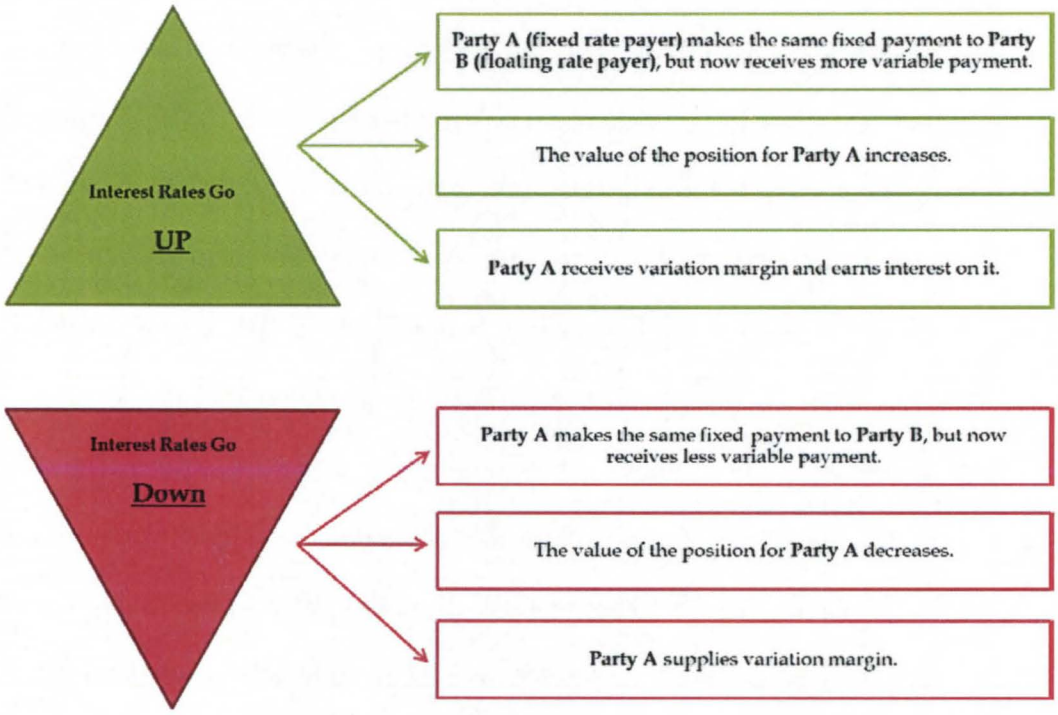
[26] IDCH was a subsidiary of the International Derivatives Clearing Group (IDCG).

[27] Fabozzi *et al.*, p. 1383.

payments (proceeds) of variation margin which they make to (receive from) the exchange depending on the value of their position based on settlement prices. **Figure 2** below illustrates the cash flows exchanged following a change in interest rates. After an increase in interest rates, Party A, the fixed rate payer, still makes the same fixed amount of payment but receives a higher variable amount. The marked-to-market value of the swap increases for Party A as interest rates increase and vice versa for Party B, the floating rate payer.

Figure 2: Illustration of Cash Flows Movements after a Change in Interest Rates



24. On a daily basis, for a cleared interest rate swap futures position (like the Three Month Contract), Party A receives variation margin when interest rates rise and earns interest on it, and is required to supply variation margin when interest rates fall. In contrast, with an OTC interest rate swap, Party A receives collateral when the value of its position increases but it does not keep the interest earned on such collateral.

VII. THE VALUE OF THE THREE MONTH CONTRACT DIFFERS FROM AN OTC INTEREST RATE SWAP DUE TO THE EXCHANGE OF VARIATION MARGINS BUT IDCH CHOSE NOT TO ACCOUNT FOR THIS WHEN IT DESIGNED THE THREE MONTH CONTRACT[28]

25. **Exhibit 1** summarizes characteristics of the Three Month Contract some of which I discuss here. The Three Month Contract required the exchange of semi-annual fixed interest rate payments agreed upon by parties for floating interest rate payments based on the 3-month LIBOR. The underlying instrument was a U.S. dollar-denominated interest rate swap and the notional value was $100,000.

26. Using its own methodology and procedures, IDCH determined a daily settlement price for each maturity. Importantly, IDCH expressly reserved for itself the sole discretion in establishing a daily settlement price that it has deemed a "fair and appropriate reflection of the market."[29] Indeed, determining the proper settlement price is one of the most important functions of an exchange or clearinghouse, especially in relatively illiquid markets where pricing information is not plentiful. IDCH then constructed the "IDEX Curve" by connecting the individual daily settlement prices across the different maturities.

27. At the close of each trading day, IDCH estimated the value of each position in the Three Month Contract by calculating the net present value of cash flows based on discount factors generated from the IDEX Curve.[30] The estimated net present value of cash flows

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[28] See Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28; Mr. O'Connor, former CEO of IDCG, testified that "[t]here were three main reasons why we did not include PAI in the futures environment. We thought it was unnecessary, we thought it was complex, and the clients that we were targeting were vocal that they did not want it in their clearing solution." See Deposition of Garry O'Connor, February 29, 2012, pp. 21-22.

[29] IDCH Rulebook, p. 100.

[30] IDCH Rulebook, p. 100.

determined each party's daily profit or loss and the variation margin to be paid to or received from IDCH.[31]

28. As with most futures contracts, IDCH had clear methods for how its IDEX Curve was set. When there was exchange activity (*i.e.*, bids, offers, and/or executed trades), IDCH used a 3-tier method for incorporating such activity into its IDEX Curve calculation.[32] In the absence of exchange activity, IDCH instead incorporated the Corresponding Rates into its IDEX Curve calculation.[33] Notwithstanding the foregoing, IDCH had final authority to act to achieve a price that was a "fair and appropriate reflection of the market."[34] IDCH made aspects of its curve calculation methodology available to market participants to give the confidence that margin accounts would be treated fairly and equitably based on these objective criteria.

29. As seen above, the Three Month Contract had the standard features of an interest rate swap combined with the daily cash flows associated with margins in an exchange-cleared futures contract. In this regard, the Three Month Contract was not equivalent to a non-cleared swap with similar terms. This fact cannot be disputed. I

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[31] IDCH Marketing Presentation, p. 9 and p. 14, D0163515 and D0163520.

[32] See Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28 ("1. Where a bid and offer exist with a maximum configurable width the average of these two rates will be used; 2. Where a bid and offer exist with a width outside that described above but a trade was recently executed within that bid and offer spread, that traded rate will be used; 3. Failing either of the above the filtered and averaged raw data feed will be used [as a] constraint such that [it] can never be higher than the current best offer or lower than the current best bid in the order book.")

[33] See Deposition of Gerard Kopera, April 2, 2015, p. 22 ("Actual market transactions got the most weight, bids and offers got the second most weight, and observed OTC prices got the least weight"); Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28 ("[Prioritizing data feeds] involves combining price information from exchange based order book and observations from the Over the Counter (OTC) environment. As the observations of exchange activity represent verifiable transactions they are given priority over OTC observations").

[34] IDCH Rulebook, p. 100.

confirm below the differences in prices between these two instruments, validating the research by Cont *et al.* (2011) and Henrard (2012).[35]

30. Other clearinghouses—such as LCH.Clearnet and the CME Group—incorporate an adjustment (known as Price Alignment Interest or "PAI") to the daily amount of variation margin on certain of their cleared interest rate products to equilibrate the cleared instruments to their non-cleared counterparts. The PAI is the interest charged by the clearinghouse on cumulative variation margin received by a party (or paid by the clearinghouse on cumulative variation margin paid by a party) in an interest rate swap transaction.[36] Importantly, IDCH did not include a PAI or any similar adjustment in the construction specification of its Three Month Contract.

31. The value of a cleared Three Month Contract differs from the value of a non-cleared OTC interest rate swap for two reasons, both related to the exchange of variation margin for the cleared instrument, which I discuss in more detail below: the NPV[37] and the convexity effects.

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[35] See Henrard, Marc, "Deliverable Interest Rate Swap Futures: Pricing in Gaussian HJM Model," OpenGamma Quantitative Research n. 5 (2012), exploring price and hedging differences between OTC interest rate swaps and interest rate swap futures. Available at http://www.opengamma.com/sites/default/files/deliverable-interest-rate-swap-futures-pricing-gaussian-hjm-model-opengamma.pdf, (hereinafter "Henrard (2012)").

[36] LCH.Clearnet defined its PAI adjustment as follows: "To minimize the impact of daily cash variation margin payments on the pricing of interest rate swaps, the Clearing House will charge interest on cumulative variation margin received and pay interest on cumulative variation margin paid in respect of these instruments. This interest element is known as *price alignment interest*." See LCH Clearnet Update to Section 3.5.2 Price Alignment Interest (PAI) Rate, Published November 17, 2008, available at http://www.lchclearnet.com:8080/Images/section%203_tcm6-47191.pdf. Henrard (2012) describes how CME integrates an adjustment for the convexity effect into the price of its cleared interest rate swap futures.

[37] Henrard (2012) refers to the NPV effect as "multiplication by a common factor … This represents the fact that the profit is paid immediately (through the margin) and not a[t] settlement," p. 45.

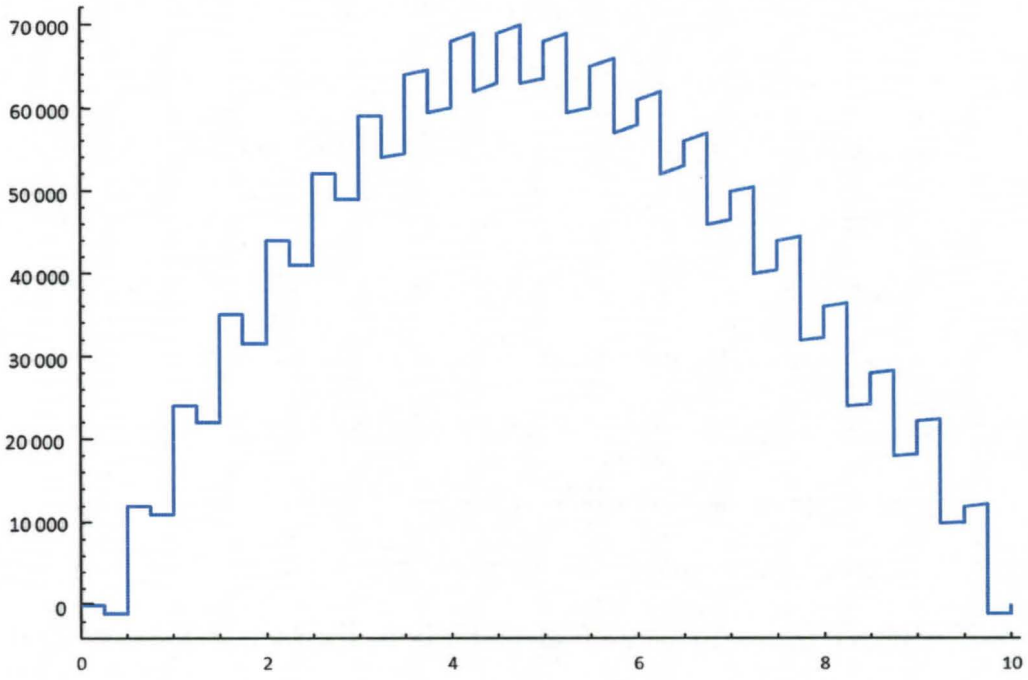
A. The Exchange of Variation Margins Generates a Net Present Value Effect

32. In an environment with an upward sloping yield curve (which is the environment that existed during the Relevant Period)—*i.e.*, rates increase over longer maturities—the remaining value of an interest rate swap increases to a positive value before it decreases to zero as it approaches expiry for the fixed rate payer (as shown in **Figure 3** below). While this is true for both an OTC interest rate swap and for the Three Month Contract, this daily change in value is actually paid to the fixed rate payer (through the payments of variation margin) only in the cleared Three Month Contract. This means that the net accumulated variation margin received by the fixed rate payer in the Three Month Contract is always positive and therefore the payer can generate a stream of positive cash flows by investing the variation received and keeping the interest. The fixed rate payer in an OTC interest rate swap doesn't receive the variation margin and as a consequence, does not receive the stream of positive cash flows. The net present value of this stream of positive cash flows is the NPV effect.

33. In other words, early in the life of the swap contract, the fixed payments exceed the floating payments because the agreed-upon fixed rate is higher than the short term variable benchmark rate. Therefore, during the time when the fixed rate is above the benchmark rate, negative cash flows accrue to the fixed rate payer and the NPV of the remaining payments is positive for the fixed rate payer. As the swap matures, the positive NPV of the remaining payments grows until the point in time where the variable rate payments exceed the fixed payments. From this point in time, the positive NPV converges toward zero at the end of the life of the swap. The fact that the fixed rate payer holds a positive NPV position, realized through the payments of variation margin, and earns interest on it during the life of the swap, is known as the NPV effect.

34. Below, **Figure 3** plots the NPV of the remaining payments for the fixed rate payer over the life of a hypothetical 10-year swap. The cumulative variation margins equal the NPV of the remaining payments at each point in time. The interest earned on these cumulative variation margins is the NPV effect.

Figure 3: Evolution of the Remaining NPV of Payments by the Fixed Rate Payer for a 10-Year Swap



B. The Exchange of Variation Margins Also Generates a Convexity Effect

35. Importantly, the NPV effect as illustrated above over the life of the contract is plotted assuming a static, upward-sloping yield curve (*i.e.*, a yield curve with higher rates at longer horizons and no volatility). In reality, interest rates change. The volatility of interest rates leads to a separate, but related, difference between OTC interest rate swap values and their cleared futures counterparts — the convexity effect.

36. As explained above, the value of an exchange-traded futures contract is marked to market on a daily basis, which includes a margining process, *i.e.*, a settlement at the end of each trading day. As a result of margining, the pattern of cash flows exchanged in a futures contract differs from that in an OTC interest rate swap, and sometimes by a substantial amount (particularly when markets are volatile). In interest rate markets, margining allows for the fixed rate payer (the buyer of the futures contract) to reinvest daily profits at a higher rate and losses to be financed at a lower rate, such that an interest rate futures contract is traded at a higher rate than a non-cleared OTC interest rate swap.

37. To illustrate this fact, consider an initial futures contract on a newly written OTC interest rate swap. If interest rates rise during the first part of the swap, the value of the futures contract will rise and the fixed rate payer (the buyer of the futures contract) will receive additional variation margin that can be invested at a higher rate. That is, the fixed rate payer collects more funds in the margin account and receives a higher interest rate on these funds (since rates have risen).

38. However, the opposite is not true, which leads to the convexity effect. Consider the opposite case where interest rates fall symmetrically during the first part of the swap causing futures rates to decrease. In this case, the fixed rate payer (the buyer of the futures contract) will post additional variation margin. However, while the margins are identical and opposite for the two cases, the interest earned on the variation margin received when interest rates rise is higher than the interest paid on the variation margin posted when interest rates decrease. That is, since margins are interest bearing accounts, the fixed rate payer (the buyer of the futures contract) makes more interest on the

additional margin than does the floating rate payer (the seller of the futures contract).[38] The average benefit (in present value terms) for the fixed rate payer (the buyer of the futures contract) represents the convexity effect.[39]

39. Expected interest rate volatility is the subject of numerous financial models and, depending on the model of choice, the size of the estimated convexity effect can vary from trader to trader. Importantly, however, the convexity effect is real and makes the value of a swap futures position differ from that of an OTC interest rate swap. Although quantifying the NPV and convexity effects requires some modeling, both benefit the fixed rate payer in an interest rate swap futures contract. The fixed rate payer, therefore, would pay a higher fixed rate in a cleared futures contract than in an OTC interest rate swap with the same terms.

40. As mentioned above, many exchanges account directly for the NPV and convexity effects by assessing PAI, which is incorporated into the settlement process on the exchange. LCH.Clearnet SA, for instance, specifies that each "Clearing Member that receives Variation Margin payments from LCH.Clearnet SA is required to pay Price Alignment Interest."[40] When applied, the PAI is expressly stated "to minimise distortion of pricing for Original Transactions cleared through LCH.Clearnet SA as a result of daily

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[38] Equivalently, the interest foregone on lower margin account funds is greater for the fixed rate payer (the buyer of the futures contract) when rates decrease.

[39] Complaint ¶21.

[40] See full set of PAI rules in LCH.Clearnet, CDSClear LCH.Clearnet SA, CDS Clearing Procedures, Section 2.14 – Margin and Price Alignment Interest, Published December 23, 2013. Available at: http://ftp.lch.co.uk/Images/cdsclear_section_2_procedures_combined_version_23_december_2013_tcm6-64469.pdf. The CME Groups also charges PAI to the receiver of variation margin funds. Henrard (2012), p. 1.

Variation Margin payments and changes in the net present value of Open Positions."[41] These payments are calculated and applied on a daily basis by this exchange/clearinghouse.

41. Without PAI, LCH.Clearnet notes that the "transfer of Collateral in respect of variation margin, or change in NPV, on a daily basis *without adjustment would distort the pricing* for SwapClear Transactions cleared through the Clearing House."[42] (Emphasis added.) Given that the Three Month Contract lacked a PAI adjustment, the difference in value between the Three Month Contract and its non-cleared counterpart would be accounted for in another way, such as higher fixed rates that incorporate the value of the NPV and convexity effects. Indeed, only with the NPV and convexity effects reflected in daily settlement prices would IDCH contract prices reflect the Three Month Contract's true economic value. In fact, DRW's bids on the Three Month Contract rationally did this exact thing—DRW bid higher yields for the Three Month Contract, reflecting its willingness to pay a premium (relative to the Corresponding Rates) to the short futures side. These higher bids were closer to the true economic value of the Three Month Contract than the Corresponding Rates would have been.

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[41] LCH.Clearnet set its PAI rate at the effective federal funds rate for U.S. dollar denominated interest rate swaps. LCH.Clearnet, FCM Procedures of the Clearinghouse, LCH.Clearnet Limited, June 2015. Available at: http://www.lchclearnet.com/documents/731485/762514/FCM+Procedures+-+23+06+15.pdf/fbf5ff8d-6b3e-4ea2-9cab-95d507b0c9a0. Also LCH.Clearnet, CDSClear LCH.Clearnet SA, CDS Clearing Procedures, Section 2 – Margin and Price Alignment Interest, Published December 23, 2013. Available at: http://ftp.lch.co.uk/Images/cdsclear_section_2_procedures_combined_version_23_december_2013_tcm6-64469.pdf.

[42] LCH.Clearnet, LCH.Clearnet Limited Procedures Section 2C Swapclear Clearing Service, See Section 1.7.4, June 2014, p. 18. Available at http://www.lchclearnet.com/documents/515114/632069/Procedures+section+2C+SwapClear+Service.pdf/8e86cd6d-5064-4184-8a7b-10e09a415e26.

42. The convexity effect is also present in other markets that have structural cash flow differences between non-cleared and cleared markets. For instance, the Eurodollar futures market also reflects the convexity effect. **Exhibits 2A** and **2B** display the values of the implied par coupon from 7- and 10-year Eurodollar futures strips along with the corresponding non-cleared OTC interest rate swap rate. In both figures, we see that the value of the par coupon implied by the Eurodollar futures strip differs from the corresponding OTC interest rate swap rates due to the NPV and convexity effects, which averaged around 22 and 35 basis points, respectively, for the 7-year swap and 10-year swap over the Relevant Period. Similar to the NPV and convexity effects in the Three Month Contract, the historical Eurodollar convexity effect ranges between 10 and 40 basis points, and is larger for the longer-term contract.[43] Without adjustment to counteract the NPV and convexity effects (like, for example, PAI), the NPV and convexity effects benefit the party with the long position at the expense of the party with the short position.

43. In various depositions, DRW's employees have demonstrated their understanding of the NPV and convexity effects to explain why they bid at higher yields for the Three Month Contract.[44] According to their testimony, all of DRW's bids (both during and outside of the Settlement Period) reflected DRW's calculations of the NPV and convexity effects — they bid at higher yields, reflecting the fact that the short party could be expected to demand a higher yield to offset the NPV and convexity effects.

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[43] Burghardt, Gerhard and William Hoskins (1994), "The Convexity Bias in Eurodollar Futures," Dean Witter Institutional Futures Research Note, p. 12.

[44] See Deposition of Donald R. Wilson, Jr., April 2, 2013, p. 56 and p. 103; Deposition of Craig Silberberg, December 03, 2014, pp. 89-90; Deposition of Brian Vander Luitgaren, November 19, 2014, pp. 66-67.

C. IDCH Recognized the Presence of the NPV and Convexity Effects in its Pricing

44. Garry O'Connor, former CEO of IDCG, has stated that he was aware of the fact that the lack of a PAI adjustment (or any other feature to compensate for the cash flows that would benefit the long party) led to a valuation difference between the Three-Month Contract and the corresponding OTC interest rate swap.[45]

45. Also, by November 2010, IDCG recognized that there was a convexity effect in its pricing of a different cleared OTC contract that it was offering and decided to implement a PAI adjustment to those contracts.[46]

D. The Corresponding Rates Are an Inaccurate Reference to Use to Settle the Three Month Contract Because, as a Result of the NPV and Convexity Effects, They Do Not Reflect Supply or Demand for the Three Month Contract

46. When the Corresponding Rates are used as a default price for the Three Month Contract, as IDCH did prior to the bids at issue in this matter, the settlement price will not reflect true supply or demand or fair value for the Three Month Contract. To the contrary, OTC prices will surely differ from prices of the Three Month Contract when the term structure of interest rates is not flat or when interest rates are not constant and not expected to remain constant (as is typically the case and was the case during the

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[45] Deposition of Garry O'Connor, February 29, 2012, pp. 21-22.

Findings of Fact and Conclusions of Law in *Jefferies & Company, Inc. v. The NASDAQ OMX Group, Inc., International Derivatives Clearing Group, LLC, and International Derivatives Clearinghouse, LLC*, January 9, 2013, JEF-CFTC-476403-33, at Findings of Fact ¶28 and Conclusions of Law ¶22 (By October 15, 2010, "IDCG learned or had reason to know that … Jefferies' September trades exposed Jefferies to substantially different risks from OTC IR Swaps of the same terms. Because of this knowledge, IDCG represented that it was endeavoring to include a PAI or PAI-like adjustment in the IR Swaps to which Jefferies was exposed…").

Email exchange between Michael Dundon and Rae Etherington regarding IDCH Adjustment of Revaluation Curve, January 24, 2011, JEF-CFTC-474513-514.

[46] IDCH Notice to Members No. 0003-10, Payment of Price Alignment Interest (PAI) into Variation Performance Bond for OTC Contracts Cleared by OTC Clearing Members, November 15, 2010, Exhibit 8 – JEF-CFTC-00000194-196.

Relevant Period). Moreover, any prices derived from the OTC market would be routinely and summarily considered by the market as inferior information sources relative to actual competitive bids in the Three Month Contract market—DRW's bids in this case.[47]

47. The fact that OTC rates (*i.e.*, the Corresponding Rates) can be (and were) used by IDCH as reference rates for the Three Month Contract given the lack of actual electronic bids does not mean that the Corresponding Rates were the most appropriate rates to apply. As noted above, the Three Month Contract and its non-cleared OTC interest rate swap counterpart have different economic values. Just as the process for valuing a home in Boston might be similar to the process for valuing a home in Detroit, it would not be appropriate to value Boston's real estate based on Detroit prices. The supply or demand in the two markets would differ substantially (even if the houses looked similar and some participants might be common to both markets). Likewise, given the economic differences between the Three Month Contract and an OTC interest rate swap, the supply or demand in the two markets would also be expected to differ. When IDCH used OTC interest rate swap prices alone to settle the Three Month Contract, it settled the Three Month Contract on, at best, the supply and demand for something different—the value of the non-cleared swap. As explained below, when IDCH decided to use the bids posted electronically by DRW in 2011, IDCH began to settle the Three Month Contract based more closely on supply or demand for the Three Month Contract itself.

[47] See Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28 ("As observations of exchange activity represent verifiable transactions they are given priority over OTC observations.")